

1. A lighting apparatus for emitting white light comprising:
a semiconductor light source emitting radiation at from about 250 nm to about 450 nm; and
a phosphor material radiationally coupled to the light source, the phosphor material comprising a red emitting phosphor having a peak emission between about 615 and 680 nm, an orange emitting phosphor having a peak emission between about 575 and 615 nm, a green emitting phosphor having a peak emission between about 500 and 575 nm, a blue emitting phosphor having a peak emission between about 400 and 500 nm, and one or more additional gap filling phosphors, wherein said lighting apparatus has a full spectrum between 400 and 700 nm.
2. The lighting apparatus of claim 1, wherein the light source comprises one of an LED and an organic emissive structure.
3. The lighting apparatus of claim 1, further comprising an encapsulant surrounding the light source.
4. The lighting apparatus of claim 3, wherein the phosphor material is dispersed in the encapsulant.
5. The lighting apparatus of claim 1, further comprising a reflector cup.
6. The lighting apparatus of claim 1, further including a pigment, filter or other absorber capable of absorbing radiation generated between 250 nm and 450 nm.
7. The lighting apparatus of claim 1, wherein said red phosphor comprises at least one of $(\text{Mg,Ca,Sr,Ba,Zn})_4\text{Si}_2\text{O}_8:\text{Eu}^{2+},\text{Mn}^{2+}$; and $3.5\text{MgO}\cdot 0.5\text{MgF}_2\cdot\text{GeO}_2:\text{Mn}^{4+}$.
8. The lighting apparatus of claim 1, wherein said green phosphor comprises at least one of $(\text{Ca,Sr,Ba})\text{Al}_2\text{O}_4:\text{Eu}^{2+}$; and $(\text{Ca,Sr,Ba,Zn})_2\text{SiO}_4:\text{Eu}^{2+}$.

9. The lighting apparatus of claim 1, wherein said blue phosphor comprises at least one of $(\text{Ca}, \text{Sr}, \text{Ba})_5(\text{PO}_4)_3(\text{F}, \text{Cl}, \text{Br}, \text{OH})\text{:Eu}^{2+}$, and $(\text{Ca}, \text{Sr}, \text{Ba})\text{Mg}_x\text{Al}_y\text{O}_{(1+x+1.5y)}\text{:Eu}^{2+}$, wherein x is an integer between about 1 and 5 and y is an integer between about 5 and 25.
10. The lighting apparatus of claim 1, wherein said orange phosphor comprises at least one of $(\text{Mg}, \text{Ca}, \text{Sr}, \text{Ba}, \text{Zn})_2\text{P}_2\text{O}_7\text{:Eu}^{2+}, \text{Mn}^{2+}$ and $(\text{Ca}, \text{Sr}, \text{Ba})_5(\text{PO}_4)_3(\text{F}, \text{Cl}, \text{Br}, \text{OH})\text{:Eu}^{2+}, \text{Mn}^{2+}$.
11. The lighting apparatus of claim 1, wherein said gap filling phosphors are selected from one or more of $\text{Sr}_4\text{Al}_{14}\text{O}_{25}\text{:Eu}^{2+}$; $(\text{Mg}, \text{Ca}, \text{Sr}, \text{Ba}, \text{Zn})_4\text{Si}_2\text{O}_8\text{:Eu}^{2+}$; $(\text{Ba}, \text{Ca}, \text{Sr})_2\text{MgAl}_{16}\text{O}_{27}\text{:Eu}^{2+}, \text{Mn}^{2+}$, and mixtures thereof.
12. The lighting apparatus of claim 1, wherein said blue phosphor is present in a spectral weight of from about 1 to 45%, said green phosphor is present in a spectral weight of from about 15 to 60%, said red phosphor is present in a spectral weight of from about 5 to 55%, and said orange phosphor is present in a spectral weight of from about 20 to 75%.
13. The lighting apparatus of claim 1, wherein said lighting apparatus has a general CRI (R_a) greater than 90.
14. The lighting apparatus of claim 1, wherein said lighting apparatus has a mean CRI (R_1 - R_{14}) greater than 90.
15. The lighting apparatus of claim 1, wherein said lighting apparatus has a CRI (R_9) greater than 80.
16. The lighting apparatus of claim 1, wherein a color point of said phosphor material lies on or substantially on the black body locus of the CIE chromaticity diagram.
17. The lighting apparatus of claim 1, wherein said lighting apparatus has a CCT of from about 2500 to 8000 K.

18. A lighting apparatus for emitting white light comprising:

a light source emitting radiation at from about 250 to about 450 nm; and

a phosphor material radiationally coupled to the light source, the phosphor material comprising a green emitting phosphor having a peak emission between about 500 and 575 nm, a red emitting phosphor having a peak emission between about 615 and 680 nm, an orange emitting phosphor having a peak emission between about 575 and 615 nm, and a blue emitting phosphor having a peak emission between about 400 and 500 nm, wherein said lighting apparatus has a general CRI (R_a) of greater than 95.

19. The lighting apparatus of claim 18, wherein the light source comprises one of an LED and an organic emissive structure.

20. The lighting apparatus of claim 18, further comprising an encapsulant surrounding the light source.

21. The lighting apparatus of claim 20, wherein the phosphor material is dispersed in the encapsulant.

22. The lighting apparatus of claim 18, further comprising a reflector cup.

23. The lighting apparatus of claim 18, further including a pigment, filter or other absorber capable of absorbing radiation generated between 250 nm and 450 nm.

24. The lighting apparatus of claim 18, wherein said red phosphor comprises at least one of $(\text{Mg,Ca,Sr,Ba,Zn})_4\text{Si}_2\text{O}_8:\text{Eu}^{2+}, \text{Mn}^{2+}$; and $3.5\text{MgO} \cdot 0.5\text{MgF}_2 \cdot \text{GeO}_2:\text{Mn}^{4+}$.

25. The lighting apparatus of claim 18, wherein said green phosphor comprises at least one of $(\text{Ca,Sr,Ba})\text{Al}_2\text{O}_4:\text{Eu}^{2+}$ and $(\text{Ca,Sr,Ba,Zn})_2\text{SiO}_4:\text{Eu}^{2+}$.

26. The lighting apparatus of claim 18, wherein said blue phosphor comprises at least one of $(\text{Ca,Sr,Ba})_5(\text{PO}_4)_3(\text{F,Cl,Br,OH}):\text{Eu}^{2+}$, and $(\text{Ca,Sr,Ba})\text{Mg}_x\text{Al}_y\text{O}_{(1+x+1.5y)}:\text{Eu}^{2+}$,

wherein x is an integer between about 1 and 5 and y is an integer between about 5 and 25.

27. The lighting apparatus of claim 18, wherein said orange phosphor comprises at least one of $(\text{Mg,Ca,Sr,Ba,Zn})_2\text{P}_2\text{O}_7:\text{Eu}^{2+},\text{Mn}^{2+}$, and $(\text{Ca,Sr,Ba})_5(\text{PO}_4)_3(\text{F,Cl,Br,OH}):\text{Eu}^{2+},\text{Mn}^{2+}$.

28. The lighting apparatus of claim 18, further comprising one or more additional phosphors selected from the group consisting of $\text{Sr}_4\text{Al}_{14}\text{O}_{25}:\text{Eu}^{2+}$; $(\text{Mg,Ca,Sr,Ba,Zn})_4\text{Si}_2\text{O}_8:\text{Eu}^{2+}$; $(\text{Ba,Ca,Sr})_2\text{MgAl}_{16}\text{O}_{27}:\text{Eu}^{2+},\text{Mn}^{2+}$, and mixtures thereof.

29. The lighting apparatus of claim 18, wherein said lighting apparatus has a mean CRI (R_1 - R_{14}) greater than 95.

30. The lighting apparatus of claim 18, wherein said lighting apparatus has a CRI (R_9) greater than 90.

31. The lighting apparatus of claim 18, wherein a color point of said phosphor material lies on or substantially on the black body locus of the CIE chromaticity diagram.

32. The lighting apparatus of claim 18, wherein said lighting apparatus has a CCT of from about 2500 to 8000 K.

33. A lighting apparatus for emitting white light comprising:

a light source emitting radiation at from about 250 to about 450 nm; and

a phosphor material radiationally coupled to the light source, the phosphor material comprising an orange emitting phosphor having a peak emission between about 575 and 615 nm, a blue emitting phosphor having a peak emission between about 400 and 500 nm, a red emitting phosphor having a peak emission between about 615 and 680 nm, and a green emitting phosphor comprising at least one of $(\text{Ca,Sr,Ba})\text{Al}_2\text{O}_4:\text{Eu}^{2+}$; and $(\text{Ca,Sr,Ba,Zn})_2\text{SiO}_4:\text{Eu}^{2+}$.

34. The lighting apparatus of claim 33, wherein said blue phosphor comprises at least one of $(\text{Ca}, \text{Sr}, \text{Ba})_5(\text{PO}_4)_3(\text{F}, \text{Cl}, \text{Br}, \text{OH})\text{:Eu}^{2+}$, and $(\text{Ca}, \text{Sr}, \text{Ba})\text{Mg}_x\text{Al}_y\text{O}_{(1+x+1.5y)}\text{:Eu}^{2+}$, wherein x is an integer between about 1 and 5 and y is an integer between about 5 and 25.

35. The lighting apparatus of claim 33, wherein said orange phosphor comprises at least one of $(\text{Mg}, \text{Ca}, \text{Sr}, \text{Ba}, \text{Zn})_2\text{P}_2\text{O}_7\text{:Eu}^{2+}, \text{Mn}^{2+}$; and $(\text{Ca}, \text{Sr}, \text{Ba})_5(\text{PO}_4)_3(\text{F}, \text{Cl}, \text{Br}, \text{OH})\text{:Eu}^{2+}, \text{Mn}^{2+}$.

36. The lighting apparatus of claim 33, further comprising one or more additional phosphors selected from the group consisting of $\text{Sr}_4\text{Al}_{14}\text{O}_{25}\text{:Eu}^{2+}$; $(\text{Mg}, \text{Ca}, \text{Sr}, \text{Ba}, \text{Zn})_4\text{Si}_2\text{O}_8\text{:Eu}^{2+}$; $(\text{Ba}, \text{Ca}, \text{Sr})_2\text{MgAl}_{16}\text{O}_{27}\text{:Eu}^{2+}, \text{Mn}^{2+}$, and mixtures thereof.

37. The lighting apparatus of claim 33, wherein said lighting apparatus has a mean CRI (R_1 - R_{14}) greater than 90.

38. The lighting apparatus of claim 33, wherein said lighting apparatus has a general CRI (R_a) greater than 90.

39. The lighting apparatus of claim 33, wherein said lighting apparatus has a CRI (R_9) greater than 80.

40. The lighting apparatus of claim 33, further including a pigment, filter or other absorber capable of absorbing radiation generated between 250 nm and 450 nm.

41. A phosphor blend comprising $(\text{Mg}, \text{Ca}, \text{Sr}, \text{Ba}, \text{Zn})_4\text{Si}_2\text{O}_8\text{:Eu}^{2+}, \text{Mn}^{2+}$ and at least three additional phosphors: an orange emitting phosphor having a peak emission between about 575 and 615 nm, a green emitting phosphor having a peak emission between about 500 and 575 nm, and a blue emitting phosphor having a peak emission between about 400 and 500 nm.

42. A phosphor blend according to claim 41, wherein said phosphor material is capable of absorbing the radiation emitted by a light source emitting from 250-450

nm and emitting radiation that, when combined with said radiation from said light source, produces white light.

43. A phosphor blend according to claim 41, wherein said orange phosphor comprises at least one of $(\text{Mg,Ca,Sr,Ba,Zn})_2\text{P}_2\text{O}_7\text{:Eu}^{2+},\text{Mn}^{2+}$; and $(\text{Ca,Sr,Ba})_5(\text{PO}_4)_3(\text{F,Cl,Br,OH})\text{:Eu}^{2+},\text{Mn}^{2+}$.

44. A phosphor blend according to claim 41, wherein said blue phosphor comprises at least one of $(\text{Ca,Sr,Ba})_5(\text{PO}_4)_3(\text{F,Cl,Br,OH})\text{:Eu}^{2+}$, and $(\text{Ca,Sr,Ba})\text{Mg}_x\text{Al}_y\text{O}_{(1+x+1.5y)}\text{:Eu}^{2+}$, wherein x is an integer between about 1 and 5 and y is an integer between about 5 and 25.

45. A phosphor blend according to claim 41, wherein said lighting apparatus has a general CRI (R_a) greater than 90.

46. A phosphor blend according to claim 41, wherein said lighting apparatus has a mean CRI ($R_1\text{-}R_{14}$) greater than 90.

47. A phosphor blend according to claim 41, wherein said lighting apparatus has a CRI (R_9) greater than 80.

48. A phosphor blend according to claim 41, wherein a color point of said phosphor material lies on or substantially on the black body locus of the CIE chromaticity diagram.

49. A phosphor blend according to claim 41, wherein said lighting apparatus has a CCT of from about 2500 to 8000 K.